CLAIMS

We claim:

1. An apparatus for identifying a chemical moiety from a sample solution, comprising:

    (a) a substrate having a channel with at least one array for capturing and releasing a chemical moiety from a sample solution; and
    (b) a solid state nanopore system downstream from the substrate for identifying the chemical moiety received from the substrate channel after the chemical moiety has been released from the array, the nanopore system comprising
        i. a first ring electrode,
        ii. a second ring adjacent to the first ring electrode;
        iii. a nanopore adjacent to the first ring electrode and the second ring electrode and positioned to allow the chemical moiety to be positioned in the first ring electrode and the second ring electrode; and
        iv. a voltage source for electrically connecting the first ring electrode to the second ring electrode for applying a ramping potential from the first ring electrode, through a portion of the chemical moiety in the nanopore to a second ring electrode to produce a signal indicative of the portion of the chemical moiety.

2. An apparatus as recited in claim 1, further comprising a substrate for positioning the first electrode and the second electrode.

3. An apparatus as recited in claim 1, at least a first substrate for positioning the first electrode.

4. An apparatus as recited in claim 1, further comprising at least a second substrate for positioning the second substrate.

5. An apparatus as recited in claim 1, further comprising at least a first substrate for positioning a nanopore.

6. An apparatus as recited in claim 1, further comprising a means for signal detection for detecting the signal produced form the portion of the biopolymer.

7. An apparatus as recited in claim 1, where the channel is a micro fluidic channel.

8. An apparatus as recited in claim 1, wherein the array comprises a probe.

9. An apparatus as recited in claim 1, wherein the probe comprises a nucleic acid molecule.

10. An apparatus as recited in claim 1, wherein the probe comprises a protein molecule.

11. An apparatus as recited in claim 1, wherein the probe comprises a carbohydrate.

12. An apparatus as recited in claim 1, wherein the probe comprises a polysaccharide.

13. An apparatus as recited in claim 1, wherein the substrate comprises a material selected from the group consisting of silicon, plastic, rubber, glass, metal, and combinations thereof.

14. An apparatus as recited in claim 2, wherein the dimension of the micro fluidic channel is 100 microns or less.

15. An apparatus as recited in claim 1, wherein the target comprises an oligonucleotide.

16. An apparatus of claim 1, wherein the array comprises more than 100 features.

17. An apparatus of claim 1, wherein the substrate may be flexible or rigid.

18. An apparatus of claim 1, which further comprises valves in the channel that permit different fluids to be directed into the channel.

19. An apparatus of claim 1, which further comprises a temperature control device to provide a temperature controlled environment.

20. An apparatus of claim 1, which further comprises means to move the fluids through the array.

21. A method for separating and identifying a chemical moiety, comprising:

(a) contacting a solution comprising a target molecule to a probe positioned in a channel of a substrate;
(b) capturing the target molecule from the sample by contacting the target molecule to the probe;
(c) releasing the target molecule from the probe; and
(d) identifying the target molecule translocating through the nanopore system by applying a ramping electrical current form a first ring electrode through a portion of the chemical moiety to a second ring electrode to identify a portion of the chemical moiety positioned in the nanopore.

22. A method as recited in claim 24, wherein the electrical current is a tunneling current with an energy level that matches at least one conduction band energy of a portion of the chemical moiety.

23. A method as recited in claim 25, wherein the tunneling current is on resonance with the conduction band energies of a portion of the chemical moiety.

24. A method as recited in claim 24, further comprising translocating the chemical moiety through the nanopore to identify each of the translocating portions of the chemical moiety.

25. A method as recited in claim 24, wherein the order of release of the target molecule is the same as the order of binding of the target molecule to the probe.

26. A method as recited in claim 24, wherein the order of elution of the target molecule is opposite of the order of binding of the target molecule to the probe.

27. A method as recited in claim 24, wherein the step of releasing the target molecules involves heating portions of the array.

28. A method as recited in claim 24, wherein the target molecules are not labeled prior to introduction to the array.

29. A method as recited in claim 24, wherein the solution contacting the probes may comprise target molecules from more than one sample and the samples are differentially labeled.

30. An apparatus for identifying a chemical moiety from a sample solution, comprising:

    (a) a substrate having a channel with at least one array for capturing a chemical moiety from a sample solution; and
    (b) a solid state nanopore system downstream from the substrate for identifying the chemical moiety received from the substrate channel after the chemical moiety has been released from the array, the nanopore system comprising
        i. a first electrode having a first nanopore,
        ii. a second electrode adjacent to the first electrode having a second nanopore wherein the first nanopore of the first electrode is positioned with the second nanopore of the second electrode so that the chemical moiety may translocate through the first nanopore and the second nanopore; and
        iii. a voltage source for electrically connecting the first electrode to the second electrode for applying a ramping potential from the first electrode, through a portion of the chemical moiety in the nanopore to a second electrode to produce a signal indicative of the portion of the chemical moiety.

31. An apparatus as recited in claim 33, wherein the first nanopore and the second nanopores have center points and wherein the center point of the first nanopore is positioned coaxially with the center point of the second electrode.

32. An apparatus as recited in claim 33, wherein the first electrode is positioned above the second electrode.

33. An apparatus as recited in claim 33, further comprising a substrate for positioning the first electrode and the second electrode.

34. An apparatus as recited in claim 33, further comprising at least a second substrate for positioning the second electrode.

35. An apparatus for identifying a chemical moiety from a sample solution, comprising:

    (a) a substrate having a channel with at least one array for capturing a chemical moiety from a sample solution; and
    (b) a solid state nanopore system downstream from the substrate for identifying the chemical moiety received from the substrate channel after the chemical moiety has been released from the array, the nanopore system comprising
        i. a first electrode,
        ii. a second electrode spaced from the first electrode to define a nanopore between the first electrode and the second electrode, the nanopore designed for receiving a tranlocating chemical moiety, the first electrode being in electrical connection with the second electrode; and
        iii. a voltage source for electrically connecting the first electrode to the second electrode for applying a ramping potential from the first electrode, through a portion of the chemical moiety in the nanopore to a second electrode to produce a signal indicative of the portion of the chemical moiety.

36. An apparatus as recited in claim 38, wherein the biopolymer is translocated in a stepwise fashion through the nanopore defined between the first electrode and the second electrode.

37. An apparatus for identifying a chemical moiety from a sample solution, comprising:

    (a) a substrate having a channel with at least one array for capturing a chemical moiety from a sample solution; and
    (b) a solid state nanopore system downstream from the substrate for identifying the chemical moiety received from the substrate channel after the chemical moiety has been released from the array, the nanopore system comprising
        i. a first electrode layer having a first portion of the nanopore extending there through and exposing a first electrode edge;

        ii. a first insulator layer adjacent to the first electrode layer, the first insulator layer having a second portion of the nanopore there through and defining a first insulator edge, the first insulator edge overhanging the first electrode edge;

        iii. a second electrode layer adjacent to the first insulator layer, the second electrode layer having a third portion of the nanopore there through and defining a second electrode edge, the second electrode

edge overhanging the first insulator edge; wherein the first electrode and the second electrode may be electrically ramped for sensing the chemical moiety.

38. A nanopore structure as recited in claim 40, further comprising a substrate adjacent to the first electrode.

39. A nanopore structure as recited in claim 40, wherein the first electrode edge defines a first diameter portion of the nanopore, and the first insulator edge defines a second diameter portion of the nanopore, the first diameter portion of the nanopore being smaller than the second diameter portion of the nanopore.

40. A nanopore structure as recited in claim 40, further comprising a second insulator layer contacting the second electrode layer and being adjacent to the nanopore, the second insulator layer having a fourth portion of the nanopore there through and defining a second insulator edge, the second insulator edge overhanging the second electrode edge.

41. A nanopore structure as recited in claim 43, wherein the second insulator edge defines a third diameter portion of the nanopore, the third diameter portion of the nanopore being smaller than the second diameter portion of the nanopore.

42. A nanopore structure as recited in claim 40, wherein the first electrode layer comprises a ring structure.

43. A nanopore structure as recited in claim 40, wherein the second electrode layer comprises a ring structure.

44. A nanopore structure as recited in claim 40, wherein both the first electrode layer and the second electrode layer comprise a ring structure.

45. A nanopore structure as recited in claim 40, further comprising an electric circuit.

46. A nanopore structure as recited in claim 48, wherein the electric circuit further comprises a voltage source for electrically connecting the first electrode layer with the second electrode layer and generating a potential between the first electrode layer and the second electrode layer for sensing a chemical moiety in the nanopore.

47. A nanopore structure as recited in claim 49, wherein the voltage source comprises a time varying voltage source.

48. A nanopore structure as recited in claim 50, where the electric circuit further comprises a current sensor for sensing a resulting current.

49. A nanopore structure as recited in claim 40, where the first electrode layer comprises a material selected from the group consisting of platinum, iridium, palladium, rhodium, gold, tin, copper, zinc, iron, magnesium, cobalt, nickel, vanadium and their alloys.

50. A nanopore structure as recited in claim 40, wherein the second electrode layer comprises a material selected from the group consisting of platinum, iridium, gold, tin, copper, zinc, iron, magnesium, cobalt, nickel, vanadium and their alloys.

51. A nanopore structure as recited in claim 40, wherein the nanopore is from 1 nanometer to 300 nanometers.

52. A nanopore structure a recited in claim 40, wherein the first insulator layer comprises a material selected from the group consisting of silicon dioxide, silicon nitride, oxynitride, platinum oxide, and aluminum oxide.

53. A nanopore structure a recited in claim 40, wherein the second insulator layer comprises a material selected from the group consisting of silicon dioxide, silicon nitride, oxynitride, platinum oxide, and aluminum oxide.